The distribution, life cycle, ecology and present status of *Leptidea morsei* (Fenton 1882) in Slovenia with additional observations from Romania (Lepidoptera: Pieridae)

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Abstract: Fenton's Wood White (*Leptidea morsei* (Fenton, 1882)) is one of the most threatened and understudied butterflies in Europe. It is in decline throughout its European range, but its distribution and the reasons for its falling numbers are unknown. Problems with identification have prevented more intensive scientific studies in the past. In order to help identify *L. morsei* in the field we provide detailed wing pattern analysis along with pre-imaginal descriptions and compare these with the similar *L. sinapis* complex. Characteristic adult behaviour and habitat preferences are also described. Ovipositing was observed exclusively on plants of *Lathyrus niger* (L) Bernh. along shady woodland rides and within the confines of light oak woodland. This specific habitat, possibly the most important factor concerning the limited distribution of *L. morsei*, is under threat due to the abandonment of coppicing, the impact of deforestation and habitat fragmentation. During recent surveys in Slovenia new colonies were discovered in the central part of the country but it was also noted that numbers were declining in previously stable populations. In order to reverse this rapid decline more studies regarding its distribution and ecological requirements are necessary to implement proper habitat management.

Key words: *Lathyrus niger*, habitat, conservation.

Verbreitung, Biologie, Ökologie und aktueller Status von *Leptidea morsei* (Fenton 1882) (Lepidoptera: Pieridae) in Slovenien, mit zusätzlichen Informationen von Rumänien

Zusammenfassung: *Leptidea morsei* (Fenton, 1881) ist gleichzeitig einer der gefährdetsten und der am wenigsten untersuchten Tagfalter in Europa. Die Art geht im gesamten europäischen Verbreitungsareal zurück, aber die aktuelle Verbreitung und die Gründe des Rückgangs sind unbekannt. Bestimmungsprobleme haben bisher meist eine tiefergehende Beschäftigung mit der Art verhindert. Um *L. morsei* im Freiland leichter bestimmen zu können, geben wir eine detaillierte Analyse der Flügelzeichnung und eine Beschreibung der Präimaginalstadien im Vergleich zum ähnlichen Komplex von *L. sinapis/reali*. Charakteristisches Imaginalverhalten und Habitatpräferenzen werden auch beschrieben. Die Eiablage wurde ausschließlich an *Lathyrus niger* (L) Bernh. entlang von schattigen Waldinnensäumen und nur in einem bestimmten Eichenwaldtyp (Lathyreto-quercetum petraeae) beobachtet. Dieses spezifische Habitat, das wahrscheinlich den entscheidenden Faktor für die begrenzte Verbreitung von *L. morsei* darstellt, ist hochgradig gefährdet durch die Aufgabe der Niederwaldbewirtschaftungsweise, den Einfluß der Entwaldung und die Fragmentierung der Lebensräume. Bei aktuellen Untersuchungen in Slowenien wurden neue Vorkommen im Zentralteil des Landes entdeckt, jedoch wurde auch eine Abnahme der vorher stabilen Populationen vermerkt. Um den rapiden Niedergang der Art aufzuhalten, müssen weitere Untersuchungen zur Verbreitung und zu den ökologischen Ansprüchen durchgeführt und in ein effektives Habitatmanagement zum Schutz der Art umgesetzt werden.

Introduction

Leptidea morsei (Fenton, 1881) or Fenton's Wood White is a Palaearctic species. Its range extends from eastern Austria, Moravia and Slovenia eastwards throughout temperate Eurasia to northern Japan (Tolman & Lewington 1997). A subspecies *L. morsei major* has been described from the European part of its distribution (Grund 1905). According to van Swaay & Warren (1999) it has been recorded from 14 European countries, but records from Italy are doubtful (Beretta, pers. comm.) and have never been confirmed. A further four countries (Poland, Bulgaria, Greece and European Turkey) are listed by Höttinger (2004), but most of the records for these countries are dubious (Abadijev 2001, Lorković 1982a, 1982b, 1993; but see Leestmans & Mazel 1996).

Regardless of these uncertainties regarding distribution the current situation in Europe seems to be critical and in many parts of its European range there has been a reported decline averaging 50–80 % (van Swaay & Warren 1999). It is now reported as extinct in Serbia (Jakšić 2003), where it was formerly found at Fruška Gora at the beginning of the last century, and has most probably vanished from the Czech Republic (Konvička, pers. comm.), where it was last observed in southeast Moravia during the 1980s (Beneš et al. 2002). A recent discovery in northern Moravia needs confirmation (Beneš et al. 2002) particularly as it has not been seen in the area since its initial discovery in 1995 (Konvička, pers. comm.). Because of its close resemblance to two other *Leptidea* species (*Leptidea sinapis* Linnaeus, 1758 and *Leptidea reali* Reissinger, 1989), it has probably been overlooked and possibly misidentified in many areas. The present distribution map for this species in Europe may therefore be considered incomplete and partially erroneous.

Most studies of *L. morsei* in Europe have been carried out in northwest Croatia where Grund (1905) described a spring form *croatica* and summer form *major* of what he presumed to be *Leptidea sinapis*. Lorković (1927) subsequently raised the status of these forms to specific rank *L. major*, but at the same time remarked on

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its similarity to another *Leptidea* species, *L. morsei* from Far East Asia. In his study he described differences in the larval stages when comparing specimens with those of *L. sinapis* (it is impossible to determine whether he used larvae of *L. sinapis* or *L. reali,* both being present in the vicinity of Zagreb). He noticed that in adult larvae of *L. sinapis/reali* the dorsal lines are much thinner and more sharply defined, whilst in *L. major,* two or three dark spots are visible on the dorsal side of each segment. More pronounced differences were described in the shape of the pupa, *L. major* having a prolonged head and a flat dorsal side in contrast to a short head and a convex dorsal side in *L. sinapis/reali.* He also documented several differences in the shape and characteristics of the wing patterns of the two species, differences still widely acknowledged in current literature as key features. His oviposition experiments were mostly unsuccessful as, at the time, he failed to identify the butterflies' natural host plant. He reported that ♀♀ possibly preferred utilising "forest with closed canopy" as ovipositing sites where butterflies were difficult to follow. After the discovery of *L. major* in Russia, linking the European/Asian distribution, Lorković (1930) revised the status of *L. major* to a subspecies of *L. morsei*.

Little is known regarding the habitat and management requirements of *L. morsei* or the reasons why the species has diminished throughout much of its (European?) range, but a lot can be attributed to difficulties encountered when trying to identify *Leptidea* species. Much of the pioneering work was done by Lorković (1950), who finally succeeded in observing the oviposition of *L. morsei major* in nature on Black Pea (*Lathyrus niger* L., Fabaceae). This appears to be the only larval foodplant of *L. morsei* in Europe (Lorković 1975, Höttinger 2004, this study). Further observations (Lorković 1975, 1993) revealed an ecological association of *L. morsei* with the Oak forest Lathyreto-quercetum petraeae at the southwestern edge of its distribution and its common sympatric association with *Neptis sappho* (Pallas, 1771). Both species share *Lathyrus niger* as their primary foodplant, but the range of *Neptis sappho* is more extensive, possibly due to its wider selection of host plants including Spring Pea *Lathyrus vernus* (L.) Bernh. and False Acacia *Robinia pseudoacacia* L. (Lorković 1975, Jutzeler et al. 2000). Lorković reported that *L. morsei* had a habitat preference for light oak woodland, small clearings and forest edges. ♂♂ were more frequently encountered flying along the margins of woodland, visiting nectar-rich plants and settling on damp soil to absorb minerals. ♀♀ rarely leave their ovipositing sites, usually only doing so to mate before returning to the sanctuary of the shaded forest in search of their host plant.

Hafner (1909) was the first to report the occurrence of *L. morsei* in Slovenia at two sites near the Croatian border in the Dolenjska Region. In the Štajerska Region of NE Slovenia the presence of f. *croatica* was indicated by Hoffmann & Klos (1914). Further records were published by Lorković (1930, 1975) who partially linked up the known distribution of the species in Slovenia. An extensive search for suitable habitats carried out in 2004 expanded the westward limits of its known range in Slovenia to the regions of Kočevska, Suha Krajina and Posavje in central Slovenia (Čelik et al. 2005).

In this paper we document and describe the life cycle of *L. morsei*, and for the first time publish photos of all pre-imaginal stages. To further facilitate identification we describe in detail the wing pattern characteristics along with other distinguishing features. The status of the species in Slovenia, its possible decline and conservation measures are also discussed.

Distribution, field observations, ecology

L. morsei has two main areas of distribution in Slovenia – the hilly region north of the Gorajnci Mountains, and parts of Bela Krajina along its western boundary including the Kolpa River valley. In these areas the species was locally common and occasionally abundant less than 20 years ago (Lasan, pers. comm.). During the latter half of the 1990s Rudi Verovnik started to survey these areas. By then the species was already uncommon with only one site to the south east of Črnomelj where it was still flying in good numbers. This site, a mixture of small clearings in predominately oak forest and pastures partially overrun with hazelnut coppice, had an abundance of *L. niger*. ♂♂ and ♀♀ were observed gliding across woodland clearings before rapidly disappearing into the forest undergrowth. ♂♂ sometimes displayed a characteristic gliding movement with wings half closed, similar to the Scarce Swallowtail (*Iphiclides podalirius* L., 1758). Apart from its larger size this behaviour, when compared with *L. sinapis/reali*, is one of the most distinguishing features of the species when in flight.

The species is bivoltine throughout its range, appearing in late April–early June and late June–August in the European part of its territory (Tolman & Lewington 1997). However, most of the observations in Slovenia have been made during the spring when it can be more easily identified. The species has been recorded between 2. iv. and 1. vi. in the spring brood (f. *croatica*) and between 21. vi. and 23. vii. in the summer generation (f. *major*). The peak appearance time for the spring generation in Slovenia is during the first half of May.

Between 29. iv. and 7. v. 2006 Martin Gascoigne-Pees and Duncan Trew travelled to the Bela Krajina region

Plate 1: *Leptidea morsei* from Slovenia, Bela Krajina region, and Romania, Cluj. Unless stated otherwise all photos are from Slovenia, Bela Krajina region: **Fig. 1:** Ova attached to *L. niger* host plant. **Fig. 2:** Newly hatched L_1 larva. **Fig. 3:** Freshly moulted L_2 larva. **Fig. 4:** Larva in stage L_2. **Fig. 5:** Larva in stage L_4. **Fig. 6:** Larva in L_5. **Fig. 7:** Pupa. **Fig. 8:** Adult ♂ f. *croatica* (spring gen.): 8. v. 2006. **Fig. 9:** Adult ♀ f. *croatica* (spring gen.): 8. v. 2006. **Fig. 10:** Adult ♂ f. *major* (summer gen.): ex ovo, 16. vi. 2007, Romania, Cluj. **Fig. 11:** Adult ♀ f. *major* (summer gen.): ex ovo, 16. vi. 2007, Romania, Cluj. – Photographs by M. Gascoigne-Pees. All specimens to be donated to the Oxford University (Hope Department) Entomological collections housed at Parks Road, Oxford OX1 3PW, U.K.

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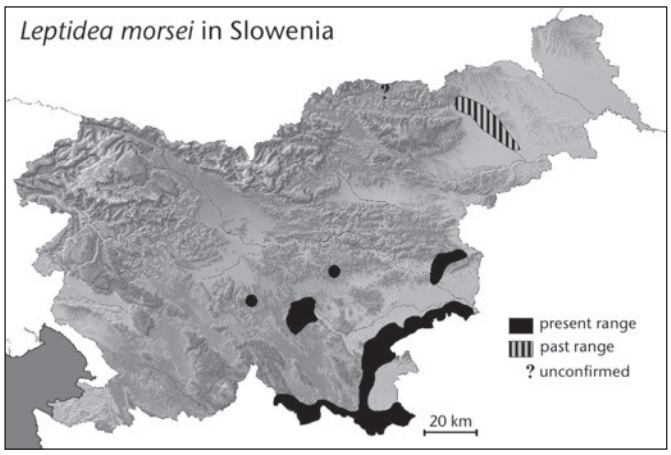

Map 1: Distribution of *Leptidea morsei* in Slovenia.

of southern Slovenia with the objective of obtaining ova of *L. morsei* for a scientific rearing programme. The site south-east of Črnomelj, where the species was abundant in the 1990s, was selected as the prime investigation area but further sites were visited. Many *Leptidea* butterflies had emerged by the end of April and individuals had to be caught and studied in detail before specimens of *L. morsei* could be positively identified. The first individual, a ♂, was observed on 2. v. flying along the edge of woodland south of Črnomelj. Several more specimens were seen in the same area, but despite an extensive search only a single egg was discovered on a leaf of *L. niger*. The host plant did not appear to be widespread and it was not until the following day that MGP and DT came across an area where *L. niger* was growing in abundance. The plant was thriving in open areas as well as deep shade, usually on sloping ground (Pl. 2, Figs. 14–15). The habitat, a mixture of grassy clearings and glades in deciduous woodland, was at an altitude of 275 m and close to the Croatian border (Pl. 2, Figs. 19–20).

Sightings of *L. morsei* were infrequent but several ♀♀ were observed gliding along one woodland ride. After a prolonged search circa 70 *L. morsei* ova were discovered in the area where the host plant was growing in a shady area. They were individually laid on the undersides of *L. niger* leaves, usually not more than one to a plant (Pl. 1, Fig. 1). The requirements for ovipositing appeared very specific. No eggs were found on plants growing in open sunny aspects or in areas where the host plant received prolonged sunlight. Ova were only found on *L. niger* plants growing along shady tracks in situations where the canopy above, usually oak, exceeded 5 m. It was noted that much of the area had recently been coppiced, a policy possibly beneficial, if not vital, both to the host plant and to the survival of *L. morsei*. *Fagus sylvatica* L. (Beech), *Acer pseudoplatanus* L. (Sycamore), *Ulmus* sp. (Elm), *Castanea sativa* Mill. (Sweet Chestnut) and *Fraxinus excelsior* L. (Ash) trees were interspersed in amongst the Oak trees. *Lathyrus vernus,* listed as an alternative host plant, was not present in either micro locality. It was, however, abundant on nearby dry grasslands south of Črnomelj. Other butterfly species seen in the vicinity included: *Leptidea sinapis* (identified from genitalia), *Neptis sappho* (Pallas, 1771), *Araschnia levana* (L., 1758), *Brenthis daphne* ([D. & S.], 1775) (larvae on *Rubus fruticosus* L. agg.), *Vanessa atalanta* (L., 1758), *Nymphalis polychloros* (L., 1758), *Anthocharis cardamines* (L., 1758), *Gonepteryx rhamni* (L., 1758), *Artogeia napi* (L., 1758), *Pararge aegeria* (L., 1758) and *Lasiommata megera* (L., 1767). *L. sinapis* far outnumbered *L. morsei* but they appeared to frequent more open, sunny areas. DT witnessed one *Leptidea* species ovipositing on *Lotus corniculatus* (L.) and other ♀♀ were seen inspecting flowers of *Lotus vicifolius* (Bernh.) (syn. *montana*).

L. morsei was encountered in two other areas in the Bela Krajina region. Several ova were discovered along a woodland track north of Črnomelj on 29. and 30. iv. and on 5. v. In addition to this a single ♂ was seen flying along a road next to the Kolpa River close to the Croatian border on 6. v. A few *L. niger* plants were discovered in nearby woodland but no ova were found.

DT revisited the habitat south of Črnomelj on 8. vii. 2006 and recorded 2 ♂♂ and 3 ♀♀ of the summer brood f. *major*. He reported that the host plant had died back by this date and that ova were fairly numerous but only on fresh secondary plant growth where the leader stalks had broken off, possibly a result of having been eaten or damaged by animals. He collected a few of these eggs and they produced a 3rd generation in captivity, emerging in late August 2006. In appearance the markings of these 3rd brood specimens are transitional between the spring and summer forms with upperside markings very similar to individuals of the 2nd generation and undersides showing considerably darker scaling along the veins of each wing. DT recorded 42 butterfly species in this area on his second visit including *Leptidea sinapis, Neptis sappho, Neptis rivularis* (Scopoli, 1763), *Brenthis hecate* ([D. & S.], 1775), *Lycaena alciphron* (Rottemburg, 1775) and *Heteropterus morpheus* (Pallas, 1771).

Occurence of *L. morsei* in Romania

L. morsei was recorded from three separate areas in Romania during a trip made by MGP and DT in late April/early May 2007. The most prolific site was an area of beech woodland north of the city of Brasov at an altitude of 665 m. The species was relatively common on their first visit on 28./29. iv. ♀♀ had already emerged and eggs were quickly discovered on the undersides of *L. niger* leaves. Several eggs of *N. sappho* were also found on *L. niger* but the ♀♀ evidently preferred laying on the upperside leaf surface. Other species of *Leptidea* were seen flying on the same habitat but specimens of *L. morsei* could be readily identified by their larger size and characteristic flight. When MGP & DT returned to the site on 6. v. they found that ova were more numerous and some had already hatched. *L. vernus* was common in the same area of woodland but despite an intensive search no eggs of *L. morsei* were found.

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Further populations of *L. morsei* were discovered in two separate areas west of Cluj between 1. and 6. v. at altitudes of 380 m and 450 m. The habitat in one area was practically identical to the site north of Brasov, dry woodland on sloping ground where *L. niger* grew abundantly under a canopy of trees. Similar to the area south of Črnomelj, the woodland appeared to have been coppiced at regular intervals.

Rearing reports

Circa 75 eggs were collected from two localities in Bela Krajina. In addition two live ♀♀ were captured and taken back to the UK for ovipositing. They were transferred to a cage containing several pots of *L. niger* that had been obtained from a local nursery in early March. As a precaution, the plants had been re-potted in uncontaminated soil.

Rearing took place indoors aided by supplementary lighting from a 60 W light bulb. The light was left on for 14 hours during the day (8:00–20:00). The authors have abstained from giving detailed information regarding the duration of each pre-imaginal stage as, presumably, under more natural conditions these periods would have been more prolonged.

Ovum

Several of the ova collected in the wild hatched in transit and had started feeding on cut leaves of *L. niger*. MGP could not confirm at this stage whether the eggs belonged to the species *L. morsei* but both MGP and DT noticed that they appeared marginally larger than those of *L. sinapis*. They were kept in a sealed plastic container under continuous light. Despite carefully separating individual eggs a percentage failed to turn yellow and died.

The 2 ♀♀ captured were transferred to a netted enclosure containing several plants of *L. niger*. The cage was placed in several situations including dappled sunlight and full shade. The ♀♀ appeared motionless during the early morning hours but became more active by midday and appeared to inspect the leaves of their host plant as the air temperature increased. Despite this attentiveness to their foodplant only 5 eggs had been deposited on the underside leaves of *L. niger* by 9. v. and by the following day the ♀♀ had died.

The egg, like that of other pierids of the same genus, is ovate/elliptical and shiny with prominent longitudinal ribs. In colour it is 'porcelain' white when laid, turning yellow after a few days and then grey prior to hatching (Pl. 1, Fig. 1). Close inspection using a hand lens revealed that there is no significant difference in the shape or the structure of the egg when compared with the ova of *L. sinapis* but it does appear to be fractionally larger in size. 4 of the 5 eggs that were laid in captivity hatched in 6 days.

Larva

The 4 eggs laid in captivity hatched on 16. v. The larvae were individually transferred to small plastic containers lined with tissue paper (Pl. 1, Fig. 2). Jim Pateman took over the rearing programme from this point in time. He reports that fresh leaves of *L. niger* were supplied each day. Under 14 h light regime they fed up quickly. There were a few casualties after the 1st instar and most of these occurred during skin change (Pl. 1, Fig. 3).

In appearance the larva is superficially difficult to tell apart from *L. sinapis* especially during the first 3 instars (Pl. 1, Fig. 4). In its final instar the larva is larger than *L. sinapis* and the two white dorsal bands are wider (Pl. 1, Figs. 5–6). Rows of dark green spots run along the exterior edges of each band. The dark green central dorsal line is very pronounced. The lateral band is paler, almost white, and fractionally broader in comparison with the larva of *L. sinapis*. A secondary dark green band is clearly visible directly above the lateral white band.

Pupa

The pupa of the summer generation is pale yellow to green in colour (Pl. 1, Fig. 7). The tip of the head is tinged pink. There are thin pink lines running along the edges of the wing casing, the veins of the wing and the costal mark. A section of the final instar larva's white lateral band (segments 7–13) can clearly be seen through the pupal casing.

Contrary to Lorković's observations we could not see any significant difference in the length of the head in relation to the overall length of the pupa in comparison with the pupa of *L. sinapis*. In fact, in appearance the pupa of *L. morsei* is virtually identical to the pupa of *L. sinapis*. 31 pupae of *L. morsei* were measured. Overall lengths ranged from 16.5 mm to 19.5 mm (averaging 18 mm). The development from pupa to imago in captivity took, on average, 11 days.

Imago/adult

13 ♂♂ and 25 ♀♀ emerged between 9. and 25. vi. 2006.

Measurements for *L. morsei*:

Spring brood (wild caught specimens):

7 ♂♂ with forewing measurements ranging from 21–23 mm (average 22.21 mm);

7 ♀♀ with forewing measurements ranging from 22.5–24 mm (average 23.07 mm).

Summer brood (ab ovo):

13 ♂♂ with forewing measurements ranging from 20.5–22.5 mm (average 21.54 mm);

25 ♀♀ with forewing measurements ranging from 20–24 mm (average 22.66 mm).

Measurements for *L. sinapis:*

Spring brood (wild caught specimens) *L. sinapis*:

5 ♂♂ with forewing measurements ranging from 20–22.5 mm (average 21.1 mm);

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5 ♀♀ with forewing measurements ranging from 20.5–21.5 mm (average 20.9 mm).

Summer brood (ab ovo):

7 ♂♂ with forewing measurements ranging from 19.5–21 mm (average 20.42 mm);

11 ♀♀ with forewing measurements ranging from 20–21.5 mm (average 20.68 mm).

Description of adults

(Refer to Pl. 1, Figs. 8–11; Pl. 2, Figs. 12, 13, 16–18 throughout this section.)

General characteristics (compared with *L. sinapis*)

L. morsei is consistently larger.

Forewing apex is falcate at V6. This is more obvious in spring brood specimens.

The uppersides and undersides of *L. morsei* are white with faint or no yellow scaling. This is especially noticeable in specimens of the summer brood.

The grey/black postdiscal band on the underside hindwing is conspicuous in both sexes. This band is more heavily marked in specimens from the spring generation but the same positioning and pattern can clearly be seen in specimens of both generations.

Spring brood (f. *croatica*) in comparison with *L. sinapis*

♂♂**:** Veins 3–9 of the upperside forewing are grey/black from the margin to the postdiscal area and are streaky and more heavily suffused at the apex along V6–9.

There is black/grey scaling visible along the veins of the underside forewing from the postdiscal area to the margins.

Apart from the area round the cell (which is white) the underside hindwing ground colour is much paler yellow and in some specimens virtually white.

There is black/grey scaling visible along the veins of the underside hindwing from the discal area to the margins.

In the centres of the spaces S1b–S8 there is faint black/grey scaling (forming faint lines) radiating out from the postdiscal area towards the margins.

The discal and postdiscal bands on the underside hindwing co-join at V5.

White patches in the discal area of S1b–S4 of the underside hindwing are clearly visible.

The veins of the underside hindwing of *L. sinapis* are (generally) more heavily suffused with black scaling (i.e. not so well defined).

In *L. sinapis* the underside hindwing is (generally) lemon yellow in colour apart from the area surrounding the cell.

♀♀**:** The dark scaling at the apex is reduced, but there is still grey/black scaling along veins 3–9 from the margins to the exterior of the postdiscal area.

Underside hindwing as for ♂.

Summer brood (f. *major*)

Summer brood specimens are more difficult to identify. The apex is not as falcate as in spring brood specimens but equally not as rounded as *L. sinapis* or *L. reali.*

♂♂**:** The interior edge of the black wedge-shaped apical mark is indented along V6–7 and S5–6 in the upperside forewing.

In many specimens of *L. morsei* there is white scaling in the margins of S5–7 of the upperside forewing indenting the dark apical mark.

The underside forewing is white apart from some faint yellow/grey scaling at the apex.

Veins 3–9 on the underside forewing are grey/black from the margin to the postdiscal area; however, this is not as obvious as in specimens from the spring brood.

The underside hindwing discal and postdiscal bands co-joined at V5 are well defined especially at S5–7 and visible through to the upperside. In *L. sinapis* the postdiscal band can be vague, washed out or absent.

The underside hindwing is white with very occasional faint yellow scaling in the submargins.

♀♀**:** The apical mark of the upperside forewing is extremely variable; sometimes absent with only a suggestion of dark scaling along V6–9, but in other specimens black/grey scaling is visible along V4–9 and the subapex can be heavily suffused with dark scales (Pl. 2, Figs. 16–18).

The underside forewing is white apart from faint yellow scaling at the apex. In *L. morsei* there is usually only a hint of yellow scaling in S4–S8, but in specimens of *L sinapis* this is more conspicuous in S1b–S8.

The postdiscal band of the underside hindwing is well defined in *L. morsei*, but can be incomplete and vague in *L. sinapis* and occasionally heavily suffused with black/grey scales.

The underside hindwing is white, occasionally with faint yellow scaling in the submargins. In comparison the underside hindwings of many specimens of *L. sinapis* can be uniform lemon-yellow in colour.

Discussion

We concur with the previous field observations of *L. morsei* in Slovenia regarding both habitat and oviposition

Plate 2: *Leptidea morsei* from Slovenia, Bela Krajina region: **Fig. 12:** Spring brood (f. *croatica*); **12a:** ♂ ups: 4. v. 2006; **12b:** ♂ uns: 3. v. 2006; **12c:** ♀ ups: 7. v. 2006; **12d:** ♀ uns: 3. v. 2006. **Fig. 13:** Summer brood (f. *major*); **13a:** ♂ ups: ex ovo, 16. vi. 2006; **13b:** ♂ uns: ex ovo, 11. vi. 2006; **13c:** ♀ ups: ex ovo, 14. vi. 2006; **13d:** ♀ uns: ex ovo, 15. vi. 2006. **Fig. 14:** *Lathyrus niger* host plant. **Fig. 15:** Flower head of *L. niger*. **Figs. 16–18:** Variation in ♀ summer gen. (f. *major*) fw apical markings. **Fig. 19:** Habitat south of Črnomelj, Bela Krajina. **Fig. 20:** Habitat north of Črnomelj, Bela Krajina. — Photographs by M. Gascoigne-Pees.

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preferences (Lorković 1975, 1993, Höttinger 2004). Adults frequently fly along forest edges, tracks and clearings in light deciduous forest, predominately oak, where there is an abundance of its larval foodplant *L. niger*. No other foodplants appear to be utilized by the larvae of *L. morsei* in Slovenia. Ova are laid singly on the underside of the leaves, exclusively in the shade of the forest. One of the most peculiar behaviours not mentioned in any of the previous publications is the characteristic gliding sometimes observed in ♂♂.

The description of the preimaginal stages is in line with Lorković's (1927) comments, except for his observation relating to the length of the pupal head. The adults we measured were, on average, larger than those of *L. sinapis,* and all, to a lesser or greater extent, displayed a falcate apex at V6. This is unquestionably the most distinguishing characteristic although it is more obvious in specimens of the spring generation. One other constant feature is the grey/black postdiscal band on the underside hindwing that is conspicuous in both sexes. This band is more heavily marked in specimens from the spring generation but the positioning and pattern can clearly be seen in specimens from both generations.

L. morsei is one of the least studied but most threatened butterfly species in Europe. Because of its inclusion in Appendix II and IV of the Habitats Directive of the European Union, its distribution has been carefully studied in several countries (Höttinger 2004 in Austria, Čelik et al. 2005 in Slovenia, Mihuc & Dinca 2006 in Romania) but there have been no recent surveys in any other European countries. The situation in Slovenia is rather paradoxical with new records extending the range of *L. morsei* further westwards by almost twofold (Map 1), but most of the new observations relate to singletons or just a few specimens. Suitable habitats with an abundance of larval foodplant are fragmented throughout its range in Slovenia and this is most evident in the western part of its distribution. Therefore it is not clear whether these new records represent specimens from viable metapopulations or remnants of isolated small populations on the verge of collapse.

Very little has been documented about the actual threats and protection measures needed to prevent the further decline of *L. morsei* in its habitats. In Burgenland, Austrian *L. morsei* is considered endangered (E) despite the discovery of several new populations in the last few years (Höttinger 2004). The main threats to the species in Burgenland are changes in woodland management practices (afforestation with conifers, lack of coppicing, dominance of dense commercial forest, indiscriminate mowing of road verges, use of herbicides, and illegal disposal of waste materials). Proposed protection measures include maintenance of open woods with traditional forestry practices, regular coppicing and the development of suitable habitat mosaics with a phased regime to encourage forestry growth and clearings (Höttinger 2004). We are of the same opinion that these threats coupled with the fragmentation of suitable habitat are the main reason for the decline of the species in Slovenia. Based on our limited field observations *L. morsei* requires large sectors of mosaic, predominantly forest, habitat. The majority of our observations are linked to light oak forests which concur with the description of the Lathyreto-quercetum petraeae habitat presented by Lorković (1993). Mapping the distribution of this prime habitat could be a useful guide for any further investigations into the status of this elusive butterfly species.

Our aim in publishing this paper is to help others identify the species in the field and document some of the special requirements needed for its survival. We hope that this publication may trigger further field surveys to help identify necessary conservation measures. The establishment of the "Natura 2000" network of protected sites has provided a good framework for the conservation of *L. morsei* in Slovenia, but further studies of its ecology, metapopulation structure, and distribution are essential to provide proper habitat management beneficial for its long term survival.

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